THE FIRST UNDERGROUND MAINS FOR ELECTRICITY SUPPLY IN BRISBANE

E. DONALD MCKENZIE AND SYDNEY A. PRENTICE

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The first Brisbane underground installation for supplying electricity for lighting is described. The original installation in 1884 used rigid two-core (No. 3 size) Edison street tubes, made in New York, U.S.A. It ran from the Queensland Government powerstation, adjacent to the Government Printing Office, along William Street for about 410m to the Queensland Parliamentary buildings. Various problems caused a two year delay before reliable supply was achieved in 1886. In 1892, when Parliament House was extended, three-core Edison street tubes (No.2 size) were added to the system with each core supplying a separate area of the building. The conductors of the older mains were bonded as a single return circuit to the powerstation. Artifacts from these systems have been collected on three separate occasions, including a planned excavation in January, 1992. Problems with voltage drop in the supply are discussed. □*Edison street tubes, underground electric mains, early electricity supply, Qld Parliament House.*

E.D. McKenzie & S.A. Prentice, Queensland Museum, PO Box 3300, South Brisbane, Queensland 4101, Australia; 15 December 1993.

Rigid underground mains, invented by Edison and known as Edison street tubes, were installed in William St, Brisbane to supply electricity for lighting purposes from the Government powerstation (adjacent to the Queensland Government Printing Office) to the Parliamentary buildings. The first installation, in 1884, was the two-core type and the second, in 1892, was the three-core type which provided for additions to the lighting. These mains were the first and only such installations in Queensland and possibly the only installation of the two-core type in the Southern Hemisphere.

Broken parts of these mains installations were recovered by the Queensland Museum from the powerstation site in 1986, and, in 1989, short lengths of the mains were recovered from the Parliament House grounds during an excavation for plumbing repairs. The work on these materials led to planned excavation and removal of a part of the mains, including complete junction boxes and elbow joint boxes in January 1992. Materials are held in the Queensland Museum.

Over the twenty years of service there was difficulty in selecting lamp voltages in the Parliamentary buildings to suit the variation in the available supply voltage with lighting load. This problem occurred initially with the voltage drop in the two-core mains and later with that for the two and three-core combination.

Units Used

As this paper refers to a time before adoption of the metric and decimal systems in Australia, the following conversions apply: 1 inch= 25.4mm; 1 foot=0.305m; 1 yard= 0.914m; 1 chain=20.1m; 1 sq. inch=645sq. mm; 1 pound (weight)=0.454kg; 1 cwt=50.7kg; 1 pound =2.0 dollars (in 1966); 1 shilling (12 pence)=10 cents.

FIRST STEPS

The first major step taken to introduce electric lighting in Queensland was the decision in April 1883 by the Queensland Government to have incandescent lighting in the House of Assembly and the Government Printing Office in Brisbane.(1) A small trial installation had just been completed in the latter building. A very brief tender, dated 11 April 1883, by a visiting representative of 'The Edison's Indian and Colonial Electric Co. Ltd (Major S. Flood Page) was accepted by the Queensland Government on 13 April. As far as is known, there was no specification. Many details were undecided and no doubt on this account and due to lack of experienced personnel, there was one difficulty after another - a situation which lasted until July 1886 when the installation was nominally complete.(2,3)

The overall plan was for the powerstation to be built adjacent to the Government Printing Office in William St, whence it could conveniently supply direct current at 110 volts (nominal) to the Printing Office and, via underground mains, to the nearby House of Assembly (Fig. 1A). In December 1884 lighting of the Legislative Coun-

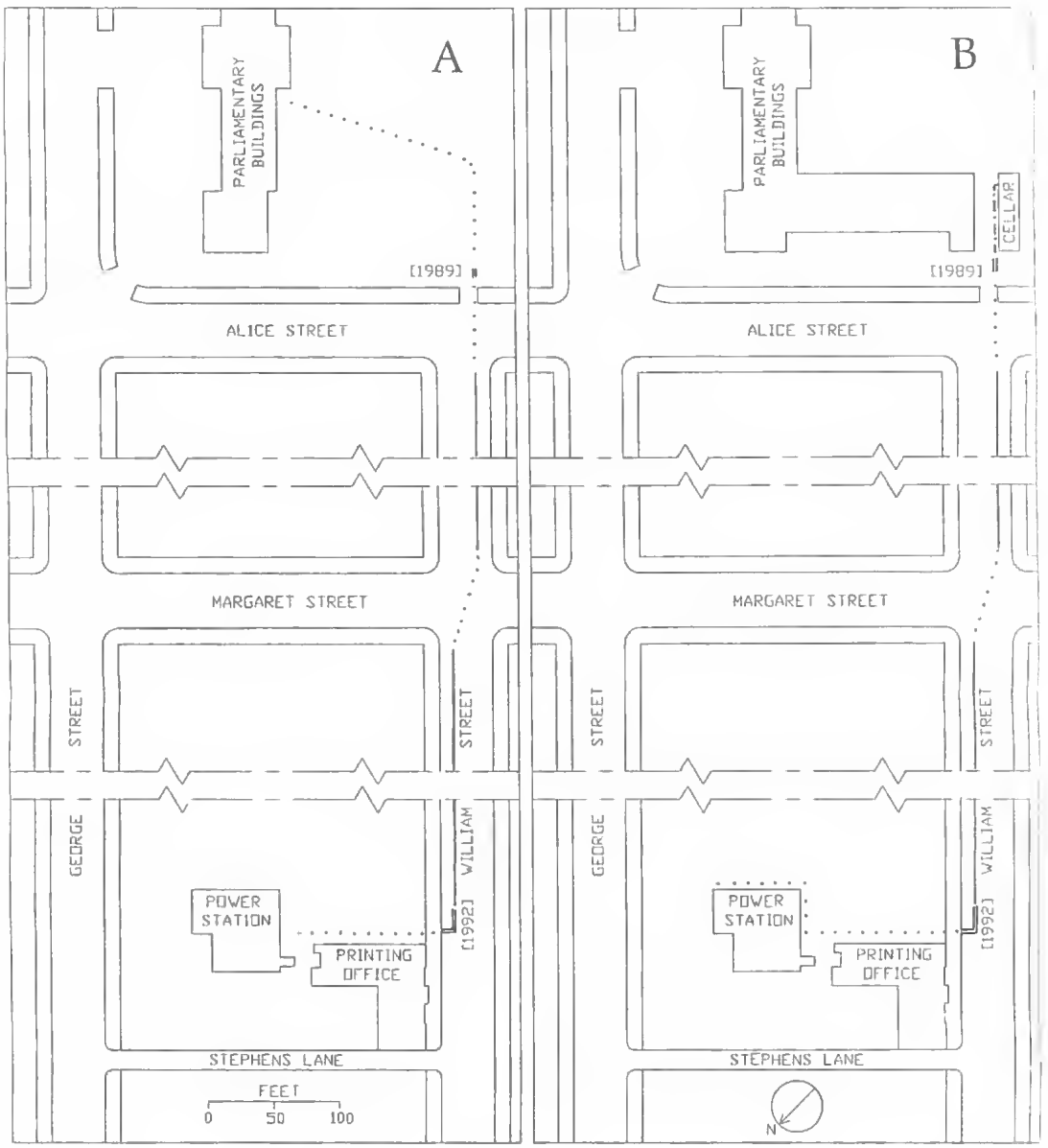


FIG. 1. A, route of the Edison two-core underground mains from the powerstation to the central tower of the Parliamentary buildings, 1884. (Approx. 1350ft). B, route of the Edison two and three-core underground mains from the powerstation to the cellar underneath the extension of the Parliamentary buildings, 1892 and later (approx. 1280ft). (Legend: – Route indicated by cable locater, SEQEB drawing 12261 A1, 1993; = Site of excavations 1989, 1992; -.- Route shown on D.A.S, drawing (Fig. 8); ..... Route otherwise assumed).

cil Chamber was added to the contract. The electrical part of the installation was to be the responsibility of the Edison Co.'s Queensland agents, Messrs Alfred Shaw and Co. The steam plant and the sets of belt drives to the dynamos were to be supplied by Messrs William Adams of

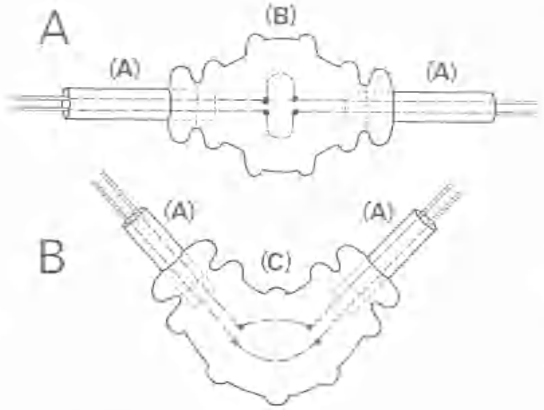


FIG. 2. Components of the Edison underground mains (street tube) two-core system. A, the ends of two street tubes (A) joined by a junction box (B); B, an elbow joint box (C) used for turning the mains at 90°. The street tubes were supplied in 15 and 20ft lengths. In the three-core system, the internal connections are similar to those for B.

Brisbane with the Government Printer responsible for the administration of the contract.(1,3)

The statement by Morwood(4) that the mains were locally made and laid in 1886 is incorrect as is that by L'Estrange(5) that the second installation in 1892 was designed by E.G.C. Barton the part-time Government Electrician. At least until 1894, Barton was responsible for the installation and use of the three-core mains and the maintenance and use of the two-core mains. Both mains (Fig. 2) were designed and manufactured by the Edison Co. in the United States. They were bought from Edison's agents in London with one exception - Barton did apparently manufacture one length of cable in 1892. A memo(6) of 3 June 1892 records a voucher for the payment to Barton, White & Co. of £5-11-10 for 'Parliamentary Buildings New Wing, making 20ft new main'. It is probable that this length of cable was used at one of the terminations of the mains; that it was the only length of three-core cable seen by Morwood or L'Estrange or both; and that this led to the belief that the whole of the three-core mains installation was of local manufacture.

DESCRIPTION OF MAINS

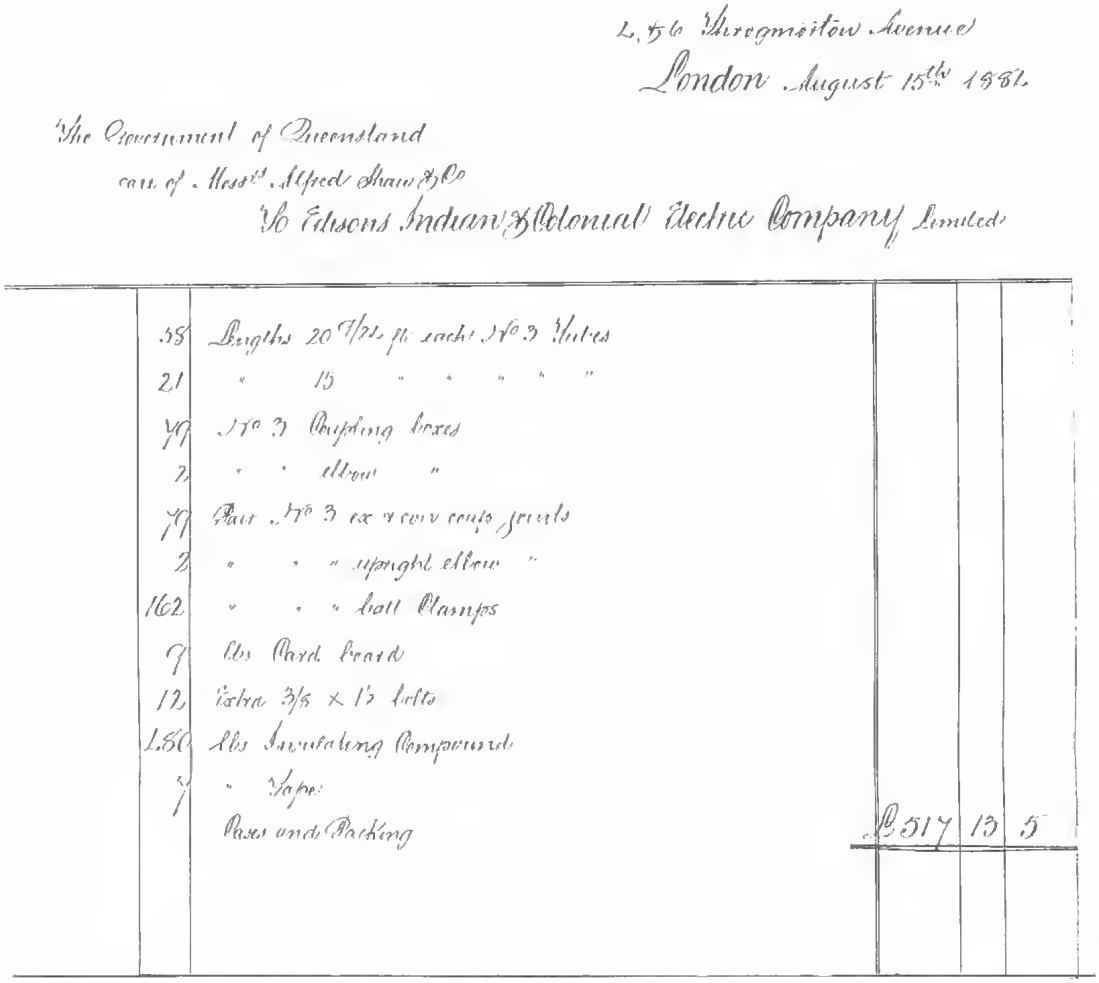
Two-core Mains

The first mains were of the two-core type and were laid in 1884 from the powerstation site, along William St, across Alice St to the tower block of the Parliamentary building.(2,3) The estimated route length is 1350ft. based on the assumed change in direction (Fig. 1A) at Margaret St., and clearance from future Parliamentary Buildings. The mains were not used regularly until 1886. No copy of the order for these has been found but an invoice(7) dated 15 August 1884 from the Edison Co. in London gives details (Fig. 3). Thus there was provision for over 1500ft of mains.

Contemporary publications give details of these Edison tubes: the U.S.A. patent for the two-core mains was applied for(8) in 1881 (Fig. 4); Wormell(9) in 1893 listed 10 different sizes, including the 'No. 3' used in the Brisbane installation; and sections of all ten sizes are given in an 1882 engineering publication.(10) The No. 3 size used copper conductors, each with a cross-section 0.206 sq. inches and tube diameter (probably external) of 2 1/4 inches.(9) It seems likely that the two-core mains supplied to Brisbane were made by the Edison Electric Tube Co., 65 Washington St, New York, the manager being John Kruesi who had been responsible for developing underground mains for Edison.(11)

The Edison tube works was moved from Washington St to Bridge St, Brooklyn, N.Y. in the northern spring of 1884(12). Thus the Brisbane material must have been manufactured at the Washington St factory. Although no direct documentary evidence has been sighted, we presume that the material was shipped from London in 1883. The street tubes were mentioned but not included in the original tender but presumably ordered later. There is documentary evidence that the installation of the cable was to be completed by mid-June 1884. Hyson(13) referred to early installations of two-core Edison mains in 'London, Milan, Brisbane, New York and other U.S. cities'. If this is taken literally, the Brisbane installation was the only one in the Southern Hemisphere.

It is likely that material used in Brisbane was surplus to requirements in London, perhaps having been sent there in 1882. It was the year(14) that the Holborn Viaduct installation was completed in London using the same two-core system. This was soon followed by their first Electricity Lighting Act, which effectively halted any further such developments until it was repealed in 1888. The Act had empowered municipalities to take over such installations without compensation after 21 years. Under such conditions, the Edison Co. in London would have



L. 56 Threegmorton Avenue
London August 15th 1882.

The Government of Queensland
care of Messrs Alfred Shaw & Co
To Edisons Indian & Colonial Electric Company Limited

58	Lengths 20 ft 2 in ft each No 3 Mains			
21	" 15 " " " " "			
79	No 3 Coupling boxes			
2	" " elbow "			
79	Pair No 3 ex 2 core ends Jewels			
2	" " " upright elbow "			
162	" " " ball Clamps			
9	lbs Card board			
12	Extra 3/8 x 15 bolts			
180	lbs Insulating Compound			
1	" Tape			
	Case and Packing	£	517	13 5

FIG. 3. The 1884 invoice for the supply of the two-core mains and accessories.

been pleased to fill the order from Brisbane with material that it may have had in stock since 1882.

The excavation for the mains in William St and restoration of the road surface were arranged by the Chief Engineer's Office of the Brisbane Municipal Council following approval by the Council in April 1884. Tenders were called and the contract awarded to J. Devenish for the sum of 17 shillings and 9 pence per chain. Work was to commence on 22 May 1884 and to be completed in 20 working days. The excavation, 'nearly 18 chains of trench', was to be 12 inches wide and deep and at every 15 or 20 feet a space 18 inches by 18 inches by 18 inches deep' was to be excavated for junction boxes.(15) From this and instructions for refilling the trench after the mains were laid, it is clear that trenching, installation and testing work must have been coordinated. Presumably J.W. Snow, an American electrician, who had been nominated as the Edison Co. representative and, who was resident in Brisbane at the time, would have been responsible for defining the route, giving the locations of the junction boxes and finally installing the mains. Snow died in Brisbane in September 1884 before the powerstation was completed. No plan of the route has been found other than the Department of Public Works drawing for part of the Parliamentary building. The specification refers only to William St and there is no reference to changes

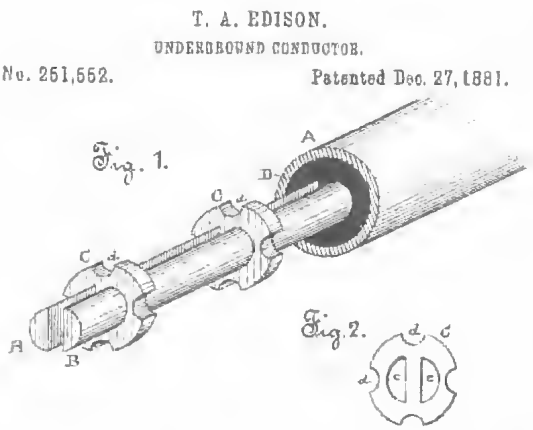


FIG. 4. Part of a diagram of the two-core mains taken from Edison's U.S. Patent.

in direction. A penalty for delay in completing the road work was to be met by Devenish at 5 pounds per week so it is probable that the contract was completed in the 20 days allowed, viz. in June 1884.

The mains had been selected to meet the intended lighting of the House of Assembly with 150 lamps and the calculated voltage drop in the mains (neglecting joints) is about 10 volts. The lighting of the Legislative Council Chamber added 50 lamps giving a calculated drop of about 13 volts. A report on the installation by a consultant in 1886 stated that 'the street mains conductors are of too small a cross-section for their purpose' and that for a generated voltage of 115 the received voltage was 92. The report stated that the lamps were for the latter voltage;also that the cost of adding another street main so as to reduce this drop would be 350 to 400 pounds.(2) There is a conflict between this value of voltage drop and the above calculated value. Further, a report by E.G.C. Barton in 1890, after about 100 lamps had been added to the 1886 installation gave a voltage drop of 25 for a current of 200 amps. (16) Inconsistencies may be due to the resistance of unsoldered connections in the system and/or errors in measurements. However, the few joints in the mains which we have seen to date appear to have been well soldered.

THREE-CORE MAINS

Because of the voltage drop problem, the Government Printer had been requesting an additional set of mains for some years when in July 1891, with the extensions to the Parliamentary buildings in progress, a specification was prepared by the Department of Works on a basis of doubling the cross-section of the mains and thus halving the voltage drop for the same current. The specification reads as follows: 'The contractor is required to provide 420 yards of Edison's three-wire street tubing in 15ft or 20ft lengths. Resistance of 420yds to be with all wires bunched in parallel, about 0. 03 ohms, so that a current of 280 amperes will experience a drop of about 8 volts. The tubing is to be provided with the required number of couplings and junction

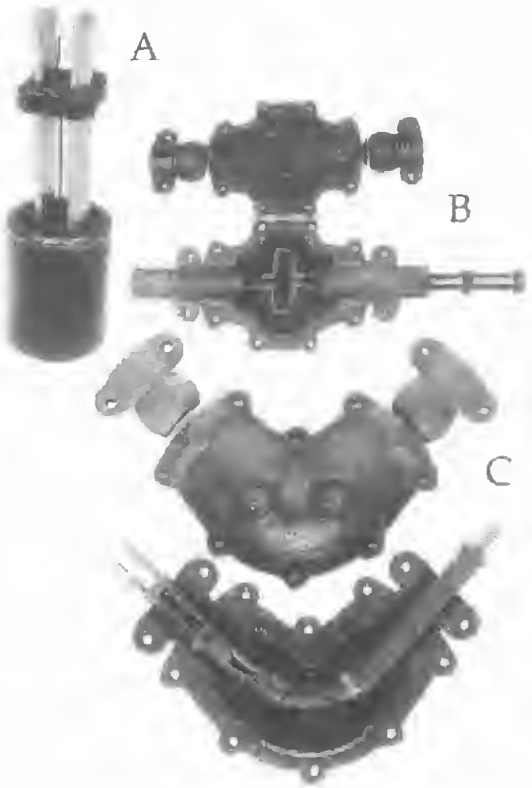


FIG. 5. Some of the material from the two-core mains, as found in Brisbane. A, a section of the Edison cable, showing how the copper conductors, with pasteboard separators held in place by a thin cord, were contained in an iron tube, filled with insulating compound; B, the junction box showing the method of joining the conductors to allow for thermal expansion or contraction of them; C, the elbow joint box - conductors here are atypical with a single-core multistrand cable joined to the older two-core system after the latter was used as the return circuit of the upgraded system in 1892. Scale is given by the 2 inch iron tubes.

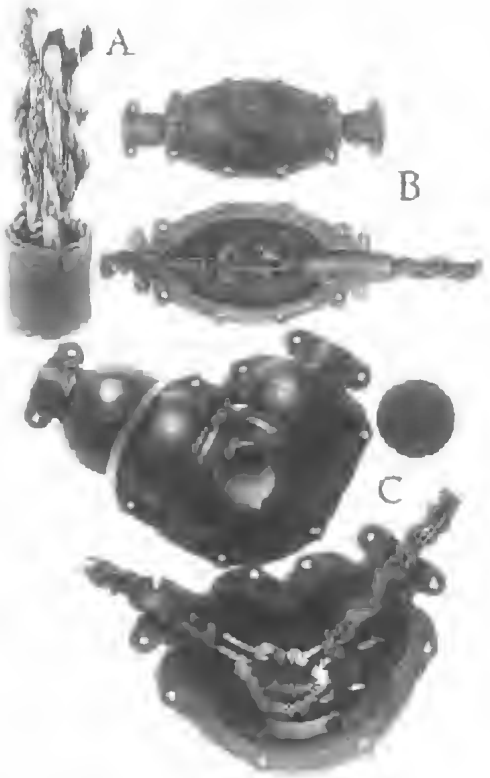


FIG. 6. Some of the material from the Edison three-core mains. A, a sectioned length of cable showing the use of spiral rope, both to insulate and separate the conductors; B, the various parts of a junction box showing the use of flexible multistrand cable to join the conductors; C, the various parts of an elbow joint box. Scale is given by the 2 inch iron tubes.

boxes, including three right-angle junction boxes, also sufficient bitumen (for tropical climate) to fill all junction boxes. An extra amount of 2cwt required above that sufficient for the new main'.(17) The indent was placed in London by the Agent General for Queensland with the Brush Electrical Engineering Co, who held the Edison patents for the Colony, for one pound per yard. The mains were delivered in Brisbane in November 1891.(18)

Each conductor is now known to be 0.12 sq. inch which agrees reasonably with that implied by the specification. Hence the three-core mains had a total area of 0.36sq.inch compared with that of the two-core mains of 0.41sq. inch.

The use of three-core mains by the Edison Co. in New York in late 1882 followed the introduction by Dr John Hopkinson in that year in England of the three-wire d.c. system.(11) It was a means of decreasing the voltage drop in the distribution system while still supplying approximately 110 volts to consumers. Thus the two-core system became obsolete.

On 8 December 1891, approval was given by the Department of Public Works for the laying of the new mains between the Printing Office and the Parliamentary buildings by day work 'under the personal supervision of the Government Electrician [E.G.C. Barton], as it is of the first importance that this work should be most satisfactorily carried out. Prices might be obtained for opening and closing of the trench along the streets at per chain'.(17) The new mains were to be laid alongside the old mains.(19) There is an intriguing request(20) by the Colonial Secretary for 'the return of the excess of 31ft supplied over that ordered'. This is apparently in conflict with the evidence already given that Barton built another length of cable for the system. However, it seems more probable that both documents indicate changing ideas about the detail of the installation as work progressed. Whereas the extra cable may have been in excess of requirements initially, the later decision to extend the underground mains around the powerstation would probably have been based on the availability of this material.

The work was completed by May 1892 after some delays for lack of components and materials needed for the completion of the three-core mains between the powerstation and the cellar in the Parliamentary grounds adjacent to the Alice St gates. Also, rerouting of the two-core mains both at the powerstation and near the Alice St entrance to the new building was needed.(21) Details of the extra material needed are seen in some of the archival material sighted. In early March, 1892, a request(21) was made for authority to cover some of the expenditure. 'The 6 sets of small junction boxes and 5 sets of Ends, where (sic!) required for the extension of the old Electric Light Main and to make good broken parts. The 3 sets of Large Junction Boxes where (sic!) required for extending the New Main round the Engine Room....' An added note by the supervising architect says that 'The fittings referred to were necessary and urgently required to complete the connection of the old and new electric mains with the dynamo at the printing office'. The estimated route length is 1280ft (Fig. 1B) based on the assumed transition at Margaret St.

Considerable work must have been done on the old mains, for as well as the extra two hundredweight (224lbs) of insulating compound ordered with the new material(17) another request(22)

was made in February 1892 for a further supply - 'the supply of Asphaltum will need replenishing as the supply sent with the mains has been used up and another cask will have to be obtained from Sydney where the Callender Bitumen Company would I believe be the proper people to apply to.' An added note says that the cost of this would not exceed 40 shillings. No doubt it was Barton's decision that, when installed, the three cores should be used as one pole and the two cores of the first mains bonded to provide the other pole of the new arrangement. It was reported that one of the cores of the new mains would supply the new wing of the Parliamentary buildings, another the Assembly and the third the Council Chamber.(23) There was a complaint that turning off the Council lamps caused a general flickering of the Assembly lamps for some minutes. The proposed remedy was to turn off the Council lamps from the powerstation switchboard by means of the available separate circuit; presumably the station voltage could then be quickly adjusted.(24)

The first trial of the new lighting in the extended buildings in June 1892 showed that the station voltage of 115 was reduced to 94 volts. The recorded current was 240 amps corresponding to about 400 lamps.(23) The calculated value of the received voltage based on conductor sizes is approximately 100 so the result must have been disappointing particularly to Barton in his dual role as part-time Government Electrician and contractor for the lighting of the new wing.

Throughout the many years of operation of the lighting system, the only solution to acceptable lighting in the many rooms of these buildings was to select lamps of lower voltage for the Parliamentary buildings than for the Printing Office. Deciding what voltage lamp should be put in what part of the building and what combination of lights should be turned on at a given time must have been a constantly recurring problem. To illustrate this it is relevant to note that in June 1892 Barton requested replenishment of lamps used in the Parliamentary buildings quoting existing stocks of lamps of voltages 92, 96, 98 and 110. In the previous year there was an indent to 'provide 100 Edison lamps with screw sockets, 16 candle power, 110 volts, also 150 Edison lamps, screwed sockets, 16 candle power, assorted 93, up to 98 volts'.(17)

MATERIAL RECOVERED

Prior to the publication by one of us (S.A.P.) (3) of a history of Edward Barton - the engineer whose name is most closely associated with this installation - we had not sighted intact samples of the underground mains or joints. The construction details were assumed to have been those given in a paper by the late F.R. L'Estrange, Consumers' Engineer, Southern Electric Authority of Queensland, who had presumably examined the disused mains.(5) The construction due to L'Estrange was reproduced on the assumption that it was correctly represented.(3)

FIG. 7. The 1992 excavation of part of the mains in William Street in progress. The elbow joint boxes are seen in the foreground. The straight junction boxes are not yet exposed at the further end of the trench. The tall building in the background is the modern (1980s) extension to the Parliamentary Buildings. The sharply pitched roof of part of the 1892 extensions is just visible above the tree-line.

In November 1986 a short damaged length of the two-core mains and a damaged three-core junction box with part of a three-core mains were discovered by the Queensland Museum at the old powerstation site (adjacent to the Government Printing Office). This showed that the conductor arrangements illustrated in the above two references were approximately correct. However, details of the insulation were not clear. Details of

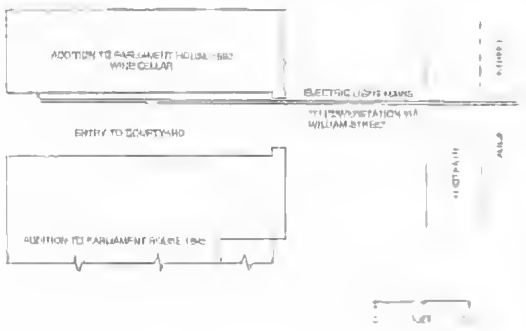


FIG. 8. Detail from part of a drawing (Dept. of Admin. Services, No. SH727, undated) showing the route of the two and three-core mains in the vicinity of the Alice Street entry to Parliament House and the entry to the wine cellar (see Fig. 9).

the three-core junction box and the internal flexible connectors were in agreement with those in a contemporary publication.(25)

In June 1989 two short lengths, one of each type of mains and evidently from the original installations, were uncovered and removed during an excavation by the Department of Works several feet inside the Alice St gateway to the Parliamentary buildings.

The two mains were found at the same depth about 10 inches apart, but circumstances did not permit the recording of full details. Four foot lengths were sawn off, and it was clear that both cables had been previously roughly severed many years before at the Parliament House end - only a few feet from the steps up to the passageway, which has replaced a previous carriageway at this point. (Thus any remaining cable within the building area (Fig. 8) is now a further few feet under the fill used here.)

The conductor details were in agreement with the pieces recovered earlier but the insulation details differed considerably from those concluded by L'Estrange.(5) Possibly the sections described by him related to terminations but not to the general run of the mains. As noted previously, he may have seen only the one piece of three-core mains that had been manufactured by Barton.

The construction of the two-core mains agrees with that described in a patent application by Edison in 1881 (Fig. 4).(8)

A contemporary textbook summarises details of the mains and junction boxes as follows: '.... the conductors were copper rods whose cross-sections were segments of circles. These were placed in wrought-iron tubes filled with insulating material and having on the outside tarred ribbons wrapped around them to prevent the oxidation of the iron. To hold the copper in position, perforated paste-boards were arranged at intervals. These conducting tubes were manufactured in lengths of 20ft and connected to each other [by junction boxes]. The copper bars protruded about 2in. from every tube and were connected by means of U shaped pieces so as to allow of the expansion and contraction of the metal;the whole was covered up by a cast iron box filled with insulating matter.'(9)

The construction of the two-core mains, revealed by our further study of them, agrees with this description (Fig. 5) except for one detail:we have looked for, but not found, evidence of the wrapping of the outside surface of the tubes with tarred ribbons.

The three-core mains are also described in a contemporary periodical.(26) 'The conductors or core of the tube are copper rods which are drawn into convenient lengths so that in the first instance each can have a layer of thin rope twisted around, and afterwards the three rods are similarly treated and placed in the wrought iron tube which resembles a gas pipe. The outer windings of the spiral come into contact with the inside of the tube and a liquid insulating material is then poured in which flows along the spiral convolutions of the cord thoroughly saturating them, and insulates the conductors from each other and from the tube... A pair of clamps are fixed on the end of the length of pipe, and furnishes it with a ball end, which rests into a hollow in the coupling box with the double object of making the joint and allowing a certain amount of elasticity, which is checked by the rib of the coupling box. To allow for expansion, the connections in the box are of stranded coppered (sic!) wire preferably of higher resistance than the copper in the mains so that the heat developed will cause the insulating material with which the box is filled to be softened.' Another contemporary description states that the flexible connections are screwed to the mains by means of set screws running through copper castings on their ends. 'After the connectors are in place they are thoroughly soldered to the ends of the mains thus making the electrical joint. The covering of the egg-shaped casting is screwed down upon the lower half;and by means of a small hole in the top of the casting, the whole of the box is filled full of melted insulating compound, thus forming an absolutely watertight joint.(25)

FIG. 9. A computer-enhanced photograph, taken from an original held by SEQEB, of the remains of both the two- core and the three-core systems emerging from the wall of the cellar of Parliament House (cf. Fig. 8). These were destroyed during the 1980s renovations of this building.

Details of the recovered tubes and fittings are in agreement with the foregoing descriptions. They are illustrated in (Fig. 6).

Missing from the earlier discoveries were a two-core junction box, a complete three-core junction box and two and three-core elbows. Interest in completing the array of components led to agreement by the South East Queensland Electricity Board (SEQEB) to undertake a search for the original mains in William St using a locating device which detects underground metal pipes. In January 1992 a likely site for the mains and elbows was discovered adjacent to the site of the original powerstation. An excavation exposed lengths of both types of mains, both types of junction boxes and both types of elbows, all virtually undamaged (Fig. 7).(27)

Although there are some corrosion problems with the cast iron material, it is in surprisingly good condition after spending a century in such a shallow location underground. Undoubtedly we have been fortunate that this street was never chosen as a route for Brisbane's extensive electric tramways system.

One unexpected result of the 1992 excavation was the discovery that the cable running from the two-core elbow joint box, where the mains turned at 90° towards the powerstation, was not a two-core cable but a lead-sheathed, paper insulated stranded copper conductor comprising 37 strands of 12SWG wire to form a single return circuit. This was proof of the bonding of the two-core cable conductors to form a single return line. The archival material reveals (28) that one 20ft length of cable was replaced in 1894. It is reasonable to assume that the length replaced was this one.

The insulating compound used in these mains is said(12) to have been a mixture of refined Trinidad lake pitch, oxidised (with lead oxide) linseed oil, beeswax and paraffin wax - a combination that was decided upon after an exhaustive search for the best available insulating compound by Edison's team in 1881. Chemical details of insulating materials will be reported elsewhere but the main points are: firstly, a confirmation of the documentary source of most of the materials used; secondly, there is a consistent difference in viscosity of the compound between the earlier and the later systems - the two-core tubes contain a significantly more viscous compound than the three-core tubes; and finally, there are differences in the compound used in the several junction boxes studied. The latter differences are consistent with the compound used to fill the junction boxes having come from different sources, as already noted.

ROUTE OF MAINS

No complete record of the route of the mains has been found. Known and assumed details (Fig. 1A,B) have been obtained from documentary evidence, the 1989 and 1992 excavations and the SEQEB field survey(27).

For much of the route the three-core installation apparently paralleled that of the original two-core mains. However, both at the powerstation end, and at the Parliament House end, the two-core system had different terminations, most of the details of which are now lost.

For the Parliament House end we have some details of the 1892 terminations in a drawing and in a photograph. A Department of Public Works (now Administrative Services) drawing No. SH727 (undated) shows the route of the two types

FIG. 10. A "Harper's Weekly" illustration of the laying of the original Edison underground mains in New York, U.S.A. These supplied electricity over a square mile of Manhattan from the Pearl Street generating station in 1882.

of mains near the point of recovery of short lengths in 1989 and also the entry into a cellar within the Parliamentary buildings area, adjacent to the Alice St gates (Fig. 8). The entry is shown in a 1936 photograph (Fig.9), held by the SEQEB Historical Records. Nothing remains of these terminations: they were taken out and discarded when the walls of this cellar were relined during the major re-furbishment of Parliament House in 1982. Neither the foreman-in-charge nor the supervising architect has been able to supply any useful details of these cables. However, it seems likely that elbow joints for both the two-core and three-core system remain behind the cellar wall. The ground outside the cellar (the original carriageway) was not disturbed during the building work.

Interpretation of the computer enhanced photograph (Fig. 9) appears to add little of substance. The termination of the three-core system was completely lost by the time of the photograph - the ropes used for insulating the separate conductors can clearly be seen. However, for the two-core system something of the terminal arrangement appears to remain. The structure clamped or soldered to the ends of the two-core mains appears to represent part of the fitting used to bond these mains to the internal wiring. But the detail is too unclear for further speculation.

The original route of the two-core mains evidently passed in the immediate vicinity of the site of the cellar (part of the additions to the Parliamentary buildings) as there is a reference to rerouting the mains in 1892 to avoid this.(21) This is the only detail we have of the route of the original two-core mains in the grounds of Parliament House. The position of the original termination has not been identified but there is a reference (2) to the main leads from these 'street tubes' as running 'up the reporter's gallery stairs'. The latter are adjacent to the central tower of the building which then consisted only of the George St frontage.

The positions of the excavations made in 1989 and 1992 (Fig. 1A,B) help to define the route,

much of which is based on a SEQEB survey using an electronic locating device. It seems probable that the underground two-core mains originally terminated immediately inside the SW wall of the powerstation building and were continued to the dynamo room in surface wiring.(21)

There appears to be no obvious reason for the route of the original mains changing from one side of William St to the other. The discontinuity at Margaret St as shown by the locater and the indicated change in the route to the opposite side of William St there suggests that either elbows were inserted at Margaret St and some 24ft of the mains were thus transverse to the general run or else the mains may have been set to curves to suit the two changes of direction as indicated. The fact that only two elbows were listed in the invoice for the whole installation of the two-core mains suggests that the mains were set in the latter way. An artist's impression of the laying of the street mains in New York in 1882 is given in Harper's Weekly (Fig. 10).(29)

The specification for the excavation in William St for the two-core mains required an excavation depth of 12in. W.M.E. L'Estrange commented on the heat of the sun melting the bitumen out of the mains and on the ingress of moisture attributable to the depth of laying being too shallow.(3) A contemporary description of practice in New York gave the depth of laying as 2ft to 2ft 6in. and this is also suggested by Fig. 10. In confirmation of L'Estrange's comments, archival records indicate problems in the first several years of use of the two-core mains as it was stated in 1891 that advantage should be taken of the opening up of William St for the installation of the second mains to overhaul the earlier mains.(19) Location of faults due to breakdown of insulation or a defect in any of the several hundred conductor joints would have required extensive trenching.

DISUSE OF MAINS AND LOCAL DEVELOPMENTS

The mains were disused by March 1907 by which time the Parliamentary buildings were receiving supply from the Ann St powerstation of the City Electric Light Co. Ltd.(30) The company had replaced its original 110 volts direct current distribution system with a 220/110 volt three-wire direct current system some ten years earlier.(3)

The type of mains discussed in this paper became obsolete as lead sheathing was substituted for iron pipes and long lengths were thus available by an extrusion process. Lead sheathed mains were in use in 1891.(31)

In central Brisbane, in 1899, the first such mains were laid by the Brisbane Electric Supply Co. Ltd along footpaths in hardwood troughs and covered with bitumen. This company's successor, the City Electric Light Co. Ltd. used 220/110 volt underground mains, installed in George Street, to supply the Parliamentary buildings (as mentioned above) and later the Printing Office. This advance in technology brings into sharp contrast the relative installation and maintenance costs as well as the improved reliability of the later as compared with the earlier types.

Two years after the initial lighting of the Parliamentary Buildings the first commercial supply of electricity in Brisbane was given by a small newly-formed firm of electricians, Messrs Barton, White and Co. (later Brisbane Electric Supply Co. Ltd).(3,32,33) They provided electric light for the General Post Office on 20 August 1888. Overhead lines were used to connect the generating plant with consumers over the next eleven years, without formal approval. Thereafter the company was obliged to conform with the Queensland Electric Light and Power Act of 1896 which required all mains to be underground. It was not until 1917 that overhead distribution mains were accepted, thus bringing electric lighting to the streets of Brisbane thirty five years after the first demonstration in Queen St.(3)

CONCLUDING COMMENTS

The Queensland Government must be credited with the initiative and foresight which resulted in the Edison Co.'s representative in Brisbane obtaining an order to light partially the Government Printing Office in April 1883, using the Edison system. This was followed immediately by the representative securing an order to light Parliament House using Edison equipment, except for the steam plant driving the dynamos.

Edison had succeeded in factory production of both dynamos and incandescent lamps by 1879. To complete the development, a system of distribution, to connect the powerstation with the consumers, was necessary. The first patent for the two-core Edison street tubes was filed in 1881; and in 1882 working systems using these street tubes were installed and operating in both New York and London. Brisbane was not far behind: considering the slower communications of the period, it is reasonable to argue that Brisbane was in the forefront of electric lighting.

This early Brisbane installation helped indirectly to promote electric lighting as a community need rather than a novelty and thus created a demand for public supply, the name of Barton being linked with all but the earliest phases. The high cost and inferior reliability of electric lighting compared with gas lighting at this stage was offset against the absence of heat and fumes.

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